

**CRITICAL ITEMS LIST**

PROJECT: SRMS (-5 MC2U INSTALLED)  
 ASS'Y NOMENCLATURE: ROTATIONAL HAND CONTROLLER

SYSTEM: D&C SUBSYSTEM  
 ASS'Y P/N: 5115E117

SHEET: 1

FMEA REF.	FMEA REV.	NAME, QTY & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	MDWR / UNC. 2/2 CRITICALITY	RATIONALE FOR ACCEPTANCE SCREENS: N/A
1435	0	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/W 5115E117	MODE: HARD OVER OUTPUT.  CAUSE(S): (1) OP AMP FAILURE.	MAXIMUM COMMANDS IN EITHER DIRECTION TO MC2U. HAND CONTROLLER HARDOVER CHECK WILL DETECT AND DROP GPC INTO IDLE. ARM WILL STOP.  WORST CASE ----- LOSS OF MISSION. LOSS OF MANUAL AUGMENTED MODES.  REDUNDANT PATHS REMAINING ----- 1) NULL COMMAND FROM GPC (FOR SAFING THE SYSTEM).  2) AUTO OR SINGLE DRIVE MODES (FOR CONTINUING OPERATIONS).	DESIGN FEATURES ----- THREE IDENTICAL CIRCUITS PROVIDE SIGNAL DEMODULATION FOR EACH OF THE THREE TRANSDUCERS.  IN EACH CIRCUIT, TWO TRANSISTORS ARE ALTERNATELY SWITCHED BY THE OUTPUT OF A TRANSFORMER WHICH IS DRIVEN BY 20 VAC, 1500HZ. THE SWITCHING ACTION OF THE TRANSISTORS RESULTS IN PHASE-SENSITIVE RECTIFICATION OF THE TRANSDUCER OUTPUT. THE RECTIFIED OUTPUT IS FILTERED, AND SCALED BY AN OPERATIONAL AMPLIFIER. ONE TRANSFORMER PROVIDES THE SWITCHING COMMANDS FOR ALL THREE CIRCUITS.  TRANSISTORS ARE 2N2432A TYPE. OP-AMPS ARE TYPE LM101A.  EEE PARTS HAVE BEEN SELECTED AND CONTROLLED IN ACCORDANCE WITH SPAR-RMS-PA.003. THIS DOCUMENT DEFINES THE PROGRAM REQUIREMENTS FOR MONITORING AND CONTROLLING EEE PARTS. THE REQUIREMENTS INCLUDE PARTS SELECTION TO AT LEAST "ESTABLISHED RELIABILITY" LEVELS, AND ADEQUATE DERATING OF PART STRESS LEVELS. PROCEDURES AND ACTIVITIES ARE SPECIFIED TO ENSURE AT LEAST EQUIVALENT QUALITY FOR NONSTANDARD AND IRREGULAR PARTS. RELIABILITY ANALYSIS HAS CONFIRMED NO PARTS WITH GENERICALLY HIGH FAILURE RATES. AEROSPACE DESIGN STANDARDS FOR DETAILING ELECTRONIC PARTS PACKAGING, MOUNTING AND STRUCTURAL/MECHANICAL/INTEGRITY OF ASSEMBLIES ARE APPLIED. SUCH DESIGN HAS BEEN REVIEWED AND FOUND SATISFACTORY THROUGH THE DESIGN AUDIT PROCESS, INCLUDING THE USE OF RELIABILITY, MAINTAINABILITY AND SAFETY CHECKLISTS. MATERIAL SELECTION AND USAGE CONFORMS TO SPAR-SG.368 WHICH IS EQUIVALENT TO THE NASA MATERIALS USAGE REQUIREMENTS. WORST CASE ANALYSIS HAS BEEN CONDUCTED TO ENSURE THAT PERFORMANCE CAN BE MET UNDER WORST CASE TEMPERATURE AND AGING EFFECTS. EEE PARTS STRESS ANALYSIS HAS BEEN COMPLETED AND CONFIRMS THAT THE PARTS MEET THE DERATING REQUIREMENTS.  PRINTED CIRCUIT BOARD DESIGNS HAVE BEEN REVIEWED TO ENSURE ADEQUATE CIRCUIT PATH WIDTH AND SEPARATION AND TO CONFIRM APPROPRIATE DIMENSIONS OF CIRCUIT SOLDER PADS AND OF COMPONENT HOLE PROVISIONS.  PARTS MOUNTING METHODS ARE CONTROLLED IN ACCORDANCE WITH MSFC-STD-136 AND CAE PD93489. THESE DOCUMENTS REQUIRE APPROVED MOUNTING METHODS, STRESS RELIEF, AND COMPONENT SECURITY.  WHERE APPLICABLE, DESIGN DRAWINGS AND DOCUMENTATION GIVE CLEAR IDENTIFICATION OF HANDLING PRECAUTIONS FOR ESD SENSITIVE PARTS.  BOARD ASSEMBLY DRAWINGS INCLUDE THE REQUIREMENT FOR SOLDERING STANDARDS IN ACCORDANCE WITH MHB 5300.4(3A) AND JSC 08B00A.  PROCESSING OF ADDRESS DECODING IS PERFORMED USING 'A' TYPE CMOS LOGIC DEVICES. INPUT DATA IS BUFFERED BY A COMPLEMENTARY TRANSISTOR STAGE. THE CMOS LOGIC CIRCUITS ARE OF THE GENERIC TYPE SERIES "4000A". THE COMPLEMENTARY TRANSISTORS ARE 2N2222A AND 2N2907A.	

PREPARED BY: MFVG

SUPERSEDING DATE: NONE

DATE: 11 JUL 91

CIL REV: 0

5040237A  
 ATTACHMENT  
 PAGE 89 OF 471

**CRITICAL ITEMS LIST**

PROJECT: SRMS (-5 MCIU INSTALLED)  
 ASS'Y NOMENCLATURE: ROTATIONAL HAND CONTROLLER

SYSTEM: D&C SUBSYSTEM  
 ASS'Y P/N: 51155E117

SHEET: 2

FMEA REF.	FMEA REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT OR END ITEM	MDWR / FUNC. 2/2 CRITICALITY	RATIONALE FOR ACCEPTANCE SCREENS: N/A
1435	0	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E117	MODE: HARD OVER OUTPUT. CAUSE(S): (1) OP AMP FAILURE.	MAXIMUM COMMANDS IN EITHER DIRECTION TO MCIU. HAND CONTROLLER HARDOVER CHECK WILL DETECT AND DROP GPC INTO IDLE. ARM WILL STOP.  WORST CASE ----- LOSS OF MISSION. LOSS OF MANUAL AUGMENTED MODES.  REDUNDANT PATHS REMAINING ----- 1) NULL COMMAND FROM GPC (FOR SAFING THE SYSTEM).  2) AUTO OR SINGLE DRIVE MODES (FOR CONTINUING OPERATIONS).		

**EXPEDITE PROCESSING**

5040237A  
 ATTACHMENT -  
 PAGE 90 OF 471

PREPARED BY: MFWG SUPERSEDING DATE: NONE

DATE: 11 JUL 91 CIL REV: 0

**CRITICAL ITEMS LIST**

PROJECT: SRMS (-5 MCIU INSTALLED)  
 ASS'Y NOMENCLATURE: ROTATIONAL HAND CONTROLLER

SYSTEM: D&C SUBSYSTEM  
 ASS'Y P/N: 51155E117

SHEET: 3

FMEA REF.	FMEA REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HOWR / FUNC. 2/2 CRITICALITY	RATIONALE FOR ACCEPTANCE SCREENS: N/A
1435	0	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E117	MODE: HARD OVER OUTPUT.  CAUSE(S): (1) OP AMP FAILURE.	MAXIMUM COMMANDS IN EITHER DIRECTION TO MCIU. HAND CONTROLLER HARDOVER CHECK WILL DETECT AND DROP GPC INTO IDLE. ARM WILL STOP.  WORST CASE LOSS OF MISSION. LOSS OF MANUAL AUGMENTED MODES.  REDUNDANT PATHS REMAINING 1) NULL COMMAND FROM GPC (FOR SAFING THE SYSTEM).  2) AUTO OR SINGLE DRIVE MODES (FOR CONTINUING OPERATIONS).		ACCEPTANCE TESTS ----- THE RHC IS SUBJECTED TO THE FOLLOWING ACCEPTANCE ENVIRONMENTAL TESTING AS AN SRU.  O VIBRATION: LEVEL AND DURATION REFERENCE TABLE 1  O THERMAL: +120 DEGREES F TO 20 DEGREES F (12 HRS PER CYCLE) 2 CYCLES TOTAL.  THE RHC IS TESTED AS PART OF THE D&C SUBSYSTEM; WHICH CONSIST OF D&C PANEL, THC AND RHC; PER TP 347.  THE TOTAL D&C SUBSYSTEM UNDERGOES RMS SYSTEM TESTING, (TP 518 RMS STRONGBACK, AND TP552 FLAT FLOOR TESTS) WHICH VERIFIES THE ABSENCE OF THE FAILURE MODE.  QUALIFICATIONS TESTS ----- THE RHC IS CERTIFIED BY SIMILARITY TO THE ORBITER USED RHC EXCEPT FOR FINGER OPERATED SWITCHES. THE BASIC DIFFERENCES IS THAT THE ORBITER RHC IS TRIPLE REDUNDANT AND THE RMS RHC IS SINGLE STRING.  FLIGHT CHECKOUT ----- PDRS OPS CHECKLIST (ALL VEHICLES) JSC 16987

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**CRITICAL ITEMS LIST**

PROJECT: SRMS (-5 HCU INSTALLED)  
 ASS'Y NOMENCLATURE: ROTATIONAL HAND CONTROLLER

SYSTEM: D&C SUBSYSTEM  
 ASS'Y P/N: 51155E117

SHEET: 4

FMEA REF.	FMEA REV.	NAME QTY. & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	NDMR / FUNC. 2/2 CRITICALITY	RAISONNE FOR ACCEPTANCE SCREENS: N/A
1435	0	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/N 51155E117	MODE: HARD OVER OUTPUT.  CAUSE(S): (1) OP AMP FAILURE.	MAXIMUM COMMANDS IN EITHER DIRECTION TO HCU. HAND CONTROLLER HARDOVER CHECK WILL DETECT AND DROP GPC INTO IDLE. ARM WILL STOP.  WORST CASE  LOSS OF MISSION. LOSS OF MANUAL AUGMENTED MODES.  REDUNDANT PATHS REMAINING  1) NULL COMMAND FROM GPC (FOR SAFING THE SYSTEM).  2) AUTO OR SINGLE DRIVE MODES (FOR CONTINUING OPERATIONS).	QA/INSPECTIONS	<p>EEE PARTS INSPECTION IS PERFORMED AS REQUIRED BY SPAR-RMS-PA.003. EACH EEE PART IS QUALIFIED AT THE PART LEVEL TO THE REQUIREMENTS OF THE APPLICABLE SPECIFICATION. ALL EEE PARTS ARE 100% SCREENED AND BURNED IN, AS A MINIMUM, AS REQUIRED BY SPAR-RMS-PA.003, BY THE SUPPLIER. ADDITIONALLY, EEE PARTS ARE 100% RE-SCREENED IN ACCORDANCE WITH REQUIREMENTS, BY AN INDEPENDENT SPAR APPROVED TESTING FACILITY. DPA IS PERFORMED AS REQUIRED BY PA.003 ON A RANDOMLY SELECTED 5% OF PARTS, MAXIMUM 5 PIECES, MINIMUM 3 PIECES FOR EACH LOT NUMBER/DATE CODE OF PARTS RECEIVED.</p> <p>WIRE IS PROCURED TO SPECIFICATION MIL-W-22759 OR MIL-W-81381 AND INSPECTED AND TESTED TO NASA JSCB000 STANDARD NUMBER 95A.</p> <p>RECEIVING INSPECTION VERIFIES THAT ALL PARTS RECEIVED ARE AS IDENTIFIED IN THE PROCUREMENT DOCUMENTS, THAT NO PHYSICAL DAMAGE HAS OCCURRED TO PARTS DURING SHIPMENT, THAT THE RECEIVING DOCUMENTS PROVIDE ADEQUATE TRACEABILITY INFORMATION AND SCREENING DATA CLEARLY IDENTIFIES ACCEPTABLE PARTS.</p> <p>PARTS ARE INSPECTED THROUGHOUT MANUFACTURE AND ASSEMBLY AS APPROPRIATE TO THE MANUFACTURING STAGE COMPLETED. THESE INSPECTIONS INCLUDE,</p> <p>PRINTED CIRCUIT BOARD INSPECTION FOR TRACK SEPARATION, DAMAGE AND ADEQUACY OF PLATED THROUGH HOLES,</p> <p>COMPONENT MOUNTING INSPECTION FOR CORRECT SOLDERING, WIRE LOOPING, STRAPPING, ETC. OPERATORS AND INSPECTORS ARE TRAINED AND CERTIFIED TO NASA MHB 5300.4(3A) STANDARD, AS MODIFIED BY JSC 08800A.</p> <p>CONFORMAL COATING INSPECTION FOR ADEQUATE PROCESSING IS PERFORMED USING ULTRAVIOLET LIGHT TECHNIQUES.</p> <p>POST P.C. BD. INSTALLATION INSPECTION, WORKMANSHIP &amp; CLEANLINESS (HONEYWELL/GOVERNMENT REP. - MANDATORY INSPECTION POINT)</p> <p>P.C. BD. INSTALLATION INSPECTION, CHECK FOR CORRECT BOARD INSTALLATION, ALIGNMENT OF BOARDS, PROPER CONNECTOR CONTACT MATING, WIRE ROUTING, STRAPPING OF WIRES ETC.,</p> <p>PRE-CLOSURE INSPECTION, WORKMANSHIP AND CLEANLINESS (CAE/GOVERNMENT REP. - MANDATORY INSPECTION POINT)</p> <p>PRE-ACCEPTANCE TEST INSPECTION, WHICH INCLUDES AN AUDIT OF LOWER TIER INSPECTION COMPLETION, AS BUILT CONFIGURATION VERIFICATION TO AS DESIGN ETC., (MANDATORY INSPECTION POINT).</p> <p>A TEST READINESS REVIEW (TRR) WHICH INCLUDES VERIFICATION OF TEST PERSONNEL, TEST DOCUMENTS, TEST EQUIPMENT CALIBRATION/ VALIDATION STATUS AND HARDWARE CONFIGURATION IS CONVENED BY QUALITY ASSURANCE IN CONJUNCTION WITH ENGINEERING, RELIABILITY, CONFIGURATION CONTROL, SUPPLIER AS APPLICABLE, AND THE GOVERNMENT REPRESENTATIVE, PRIOR TO THE START OF ANY</p>

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CIL REV: 0

5040237A  
 ATTACHMENT  
 PAGE 92 OF 471

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 ASS'Y NOMENCLATURE: ROTATIONAL HAND CONTROLLER

SYSTEM: D&C SUBSYSTEM  
 ASS'Y P/N: 5115E117

SHEET: 5

FMEA REF.	FMEA REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. 2/2 CRITICALITY	RATIONALE FOR ACCEPTANCE SCREENS: N/A
1435	0	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/N 5115E117	MODE: HARD OVER OUTPUT.  CAUSE(S): (1) OP AMP FAILURE.	MAXIMUM COMMANDS IN EITHER DIRECTION TO MCIU. HAND CONTROLLER HARDOVER CHECK WILL DETECT AND DROP GPC INTO IDLE. ARM WILL STOP.  WORST CASE ----- LOSS OF MISSION. LOSS OF MANUAL AUGMENTED MODES.  REDUNDANT PATHS REMAINING ----- 1) NULL COMMAND FROM GPC (FOR SAFING THE SYSTEM).  2) AUTO OR SINGLE DRIVE MODES (FOR CONTINUING OPERATIONS).		FORMAL TESTING (ACCEPTANCE OR QUALIFICATION).  ACCEPTANCE TESTING (ATP) INCLUDES, AMBIENT, VIBRATION AND THERMAL TESTING (CAE/GOVERNMENT REP. - MANDATORY INSPECTION POINT)  INTEGRATION OF D&C PANEL, RHC, THC AND MCIU, INSPECTIONS ARE PERFORMED AT EACH STAGE OF INTEGRATION, WHICH INCLUDES GROUNDING CHECKS, INTER CONNECT CABLE VERIFICATION, CONNECTOR INSPECTION FOR BENT OR PUSHBACK CONTACTS ETC.  SUB-SYSTEM PERFORMANCE TESTING (ATP), INCLUDES AN AMBIENT PERFORMANCE TEST. (MANDATORY INSPECTION POINT).  SRMS SYSTEMS INTEGRATION. THE INTEGRATION OF MECHANICAL ARM SUBASSEMBLIES AND THE FLIGHT CABIN EQUIPMENT TO FORM THE SRMS. INSPECTIONS ARE PERFORMED AT EACH PHASE OF INTEGRATION WHICH INCLUDES GROUNDING CHECKS, THRU WIRING CHECKS, WIRING ROUTING, INTERFACE CONNECTORS FOR BENT OR PUSH BACK CONTACTS ETC.  SRMS SYSTEMS TESTING - STRONGBACK AND FLAT FLOOR AMBIENT PERFORMANCE TEST. (SPAR/GOVERNMENT REP. - MANDATORY INSPECTION POINT)

EXPEDITED PROJECT

5040237A  
 ATTACHMENT  
 PAGE 93 OF 471

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PROJECT: SRMS (-5 MCIU INSTALLED)  
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SYSTEM: D&C SUBSYSTEM  
 ASS'Y P/N: 5115E117

SHEET: 6

FMEA REF.	FMEA REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT OR END ITEM	MDWR / FUNC. 2/2 CRITICALITY	RATIONALE FOR ACCEPTANCE SCREENS: N/A
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**CRITICAL ITEMS LIST**

PROJECT: SRMS (-5 MCIU INSTALLED)  
 ASS'Y NOMENCLATURE: ROTATIONAL HAND CONTROLLER

SYSTEM: D&C SUBSYSTEM  
 ASS'Y P/N: 5115E117

SHEET: 7

FMEA REF.	FMEA REV.	NAME, QTY, & DRAWING REF. DESIGNATION	FAILURE MODE AND CAUSE	FAILURE EFFECT ON END ITEM	HDWR / FUNC. 2/2 CRITICALITY	RATIONALE FOR ACCEPTANCE SCREENS: N/A
1435	0	ROTATIONAL HAND CONTROLLER QTY-1 SPAR P/N 5115E117	MODE: HARD OVER OUTPUT. CAUSE(S): (1) OP AMP FAILURE.	MAXIMUM COMMANDS IN EITHER DIRECTION TO MCIU. HAND CONTROLLER HARDOVER CHECK WILL DETECT AND DROP GPC INTO IDLE. ARM WILL STOP.  WORST CASE LOSS OF MISSION. LOSS OF MANUAL AUGMENTED MODES.  REDUNDANT PATHS REMAINING 1) NULL COMMAND FROM GPC (FOR SAFING THE SYSTEM). 2) AUTO OR SINGLE DRIVE MODES (FOR CONTINUING OPERATIONS).		OPERATIONAL EFFECTS ----- HAND CONTROLLER OUTPUT HARDOVER DETECTED BY GPC AND DROPS OUT OF MODE. MANUAL AUGMENTED MODES CANNOT BE USED TO COMPLETE THE MISSION. SINGLE, DIRECT DRIVE AND BACKUP STILL OPERATIVE. IF ALL DRIVE MODES ARE LOST, THE ARM CAN BE JETTISONED.  CREW ACTION ----- SELECT ALTERNATE MODE.  CREW TRAINING ----- NONE MISSION CONSTRAINT ----- NONE  OMRSD OFFLINE ----- WITH THE RHC IN THE NULL POSITION VERIFY R,P,Y OUTPUT VOLTAGES AT RHC OUTPUT.  OMRSD ONLINE INSTALLATION ----- NONE OMRSD ONLINE TURNAROUND ----- WITH THE RHC IN THE NULL POSITION VERIFY NO HAND CONTROLLER HARD OVER CHECK.

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